

BIG QUILCENE PRESCRIPTION #1.

Note: "CMR" refers to Causal Mechanism Report Summaries (Section 8.1)
"WIN" refers to Watershed Improvement Needs

Resource Sensitivity Number: CMR #16, Segments S19, S18, S17

Situation Sentence for the Area (from causal mechanism report):

Road location across Geomorphic Unit #25 & #36 presents high road maintenance from debris.

Triggering Mechanism (from causal mechanism report):

Road construction.

Rule Call for Management Prescriptions (from causal mechanism report): Minimize.

Field Observations:

Debris slides from the hill slope above Road 27-190 are deposited on the road prism. This is not directly contributing sediment to surface waters.

Prescriptions:

1. Evaluate road management objectives and long term use relative to road maintenance costs.
2. New road designs should address road stability and ability to revegetate road cut slopes.

Management Objective:

Prevent known hazards to public safety from debris on roadway.

Technical rationale:

Loss of root strength from clearcut harvest reduces effective soil cohesion and increases slope instability.

Recommendations for Enhancement/Monitoring:

None

BIG QUILCENE PRESCRIPTION #2.

Resource Sensitivity Number: CMR #32 Segments O-10 to O-12.

Situation Sentence for the Area (from causal mechanism report):

Past riparian harvest in this segment has changed the age distribution and reduced the near term LWD recruitment potential below the target level. This has also reduced the instream storage capability of this segment and increases the turbidity potential of the downstream public water supply.

Triggering Mechanism (from causal mechanism report):

Loss of riparian vegetation.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Clearcut harvest is vegetated with mixed young and dense stands.

Prescriptions:

Record of Decision applies (USDI/USDA, 1994)

Management Objective:

Encourage large conifer in riparian management zone.

Technical rationale:

Clearcut harvest in riparian area has reduced near term LWD recruitment and in-channel sediment storage capacity. Highly mobile channel within these segments and loss of woody perennials has caused bank erosion.

Recommendations for Enhancement/Monitoring:

Placement of large stable conifer LWD in appropriate reaches. Martin Fox 1994. Monitor conifer release from thinning or deciduous removal within the RMZ. Hardwood removals should be monitored for release success, success \leq 15% mortality to existing conifers.

BIG QUILCENE PRESCRIPTION #3.

Resource Sensitivity Number: CMR #54 Segment 20 and CMR #56 Segment 20

Situation Sentence for the Area (from causal mechanism report):

CMR #54: Fine sediments are delivered through as much as a twofold increase in shallow, rapid debris slides from unstable road sidecast. This sediment is routed to the diversion in Segment 20 during and immediately after storm events, raising the turbidity above the levels for public water supply. (WIN#'s 121, 122, 126, 128, 130, 132, 133, 134, 137, 138, 139, 141, 144, 145, 146, 147, 157, 196, 256 and 258)

CMR #56 Logs and coarse and fine sediment are being delivered (from WIN #124, 127, 129, 131, 154, 170, 195, 259, 260, 261 and 289) to the diversion at Segment 20 by road bed and cut erosion through cross drains and stream crossings. These inputs are being carried by peak flow events and have a high likelihood of damaging the municipal diversion facilities, and ability to supply water to the municipal water system's customers.

Triggering Mechanism (from causal mechanism report):

CMR #54 Unstable road sidecast.

CMR #56: Erosion from steep roadcuts, lack of vegetation in ditches and between roads, and water courses that trap fine sediments.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

WIN Inventory, Spring 1994 by Scott Hagerty, Soil Scientist noted numerous examples of sidecast failure that were routing fine sediment to surface waters. Turbidity measurements taken at the municipal diversion exceed the background turbidity levels at the Wilderness boundaries. During Storm events logs and coarse sediment are observed passing over the diversion.

Prescriptions:

1. No sidecast on slopes >55%.
2. Future management activities will be designed so as to not accelerate sediment delivery over natural rates.
3. Establish vegetation on bare cuts and fills and upgrade old roads to meet the current aquatic conservation strategy.
4. The following areas have been identified as the highest priority for corrective action to reduce sediment sources:

Unstable sidecast on USFS Road 2700-000 Segments S2-S10

USFS Road 2650-000 draining to Segments O1-O9

USFS Road 2740-000 draining to Segments 22

Unstable sidecast and road drainage (location, size and spacing) on USFS Road 2740-060.

Management Objectives:

Prevent accelerated sediment delivery to public water supply.

Technical rationale:

The Washington State Board of Health mandates the maximum contaminate level for turbidity for public water systems using surface water not exceed 1.0 NTU.

Debris carried by peak flow events has a high likelihood of damaging water diversion facilities.

Recommendations for Enhancement/Monitoring:

Measure turbidity before, during and after a representative sample of management activities above and below the activity.

BIG QUILCENE PRESCRIPTION #4.

Resource Sensitivity Number: CMR #55 Segment 20

Situation Sentence for the Area (from causal mechanism report):

Fine sediments are delivered through bank failures and undercutting due to stream action. This sediment is routed to the diversion in Segment 20 during and immediately after storm events, raising the turbidity above the levels for public water supply.

Triggering Mechanism (from causal mechanism report):

Stream action.

Rule Call for Management Prescriptions (from causal mechanism report: Natural process.

Field Observations:

Storm events cause river turbidity levels at the municipal diversion facility to exceed State drinking water standards.

Prescriptions:

1. Record of Decision applies (USDI/USDA, 1994).
2. Use alternative water supply or develop filtration system.

Management Objective:

Forest Service to deliver water to diversion at AA standards. Municipal water system to deliver water that meets State drinking water regulations.

Technical rationale:

The Washington State Board of Health mandates the maximum contaminate level for turbidity for public water systems using surface water not exceed 1.0 NTU.

Recommendations for Enhancement/Monitoring:

Monitor turbidity at diversion and at City Lake.

BIG QUILCENE PRESCRIPTION #5.

Resource Sensitivity Number: CMR #17 Segment S-13; CMR #21 Segment S-12

Situation Sentence for the Area (from causal mechanism report):

CMR #17 - Loss of root strength and cover from clearcut and broadcast burning in the mid 1980's has caused surface and channel erosion, with direct sediment delivery to Segment 13. This has elevated turbidity, which decreases water quality.

CMR #21 Fine sediment is being delivered to Segment 12 by surface erosion and 2 small slides, from the clearcutting and burning of the area adjacent and above this Segment. Removal of vegetation has reduced root strength and cover. This is increasing turbidity and affecting pool volume downstream.

Triggering Mechanism (from causal mechanism report):

Removal of vegetation reduces root strength over the first five to ten years after removal which reduces resistance to shallow mass movement. Vegetation removal and intense burning remove vegetative cover, duff, and the fine network of fine roots decreasing protection from water erosion.

Rule Call for Management Prescriptions (from causal mechanism report): Prevent or Avoid.

Field Observations:

Surface erosion, two small slides, and bank erosion in an intermittent channel where observed in two 10 year old clearcuts (WIN #259,260).

Clearcut harvesting within channel Segment 12 and 13 extended the stream banks. Intense heat from broadcast burning has affected soil nutrient availability slowing growth.

Management Objective:

Prevent accelerated erosion from harvest and fuels treatment. Prevent accelerated delivery of sediment and reduction of soil quality from management activities.

Recommendations:

Harvest/fuels treatment:

1. Retain interim Riparian Reserve boundaries and ROD standards and guidelines apply (USDI/USDA, 1994) for intermittent and ephemeral channels. Vegetation management shall retain root strength/large down wood and vegetation within and adjacent to channels to protect bank/channel stability and to provide filter for sediment.
2. Harvest and fuels treatment methods shall remove trees in a manner that leaves a minimum of 80% of the ground area cover of duff in place on slopes greater than 35%.
3. Broadcast burning shall consume no more than 50% of the duff thickness. Post burn monitoring should evaluate whether prescription has been met. If potential for reduction site quality or sediment delivery, erosion control treatments will be employed (water bars, seeding).

Technical rationale:

Field observations indicate that intermittent channels were the most sensitive to surface erosion when vegetation was removed through harvest/burning. The 80% (No. 2) duff cover and 50% duff thickness will assure compliance with USDA-FS policy for Regional Soil Quality standards (FSM 2500).

Restoration/Enhancement/Monitoring:

Reduce current erosion by seed/mulch and planting bare soil areas.

Monitor survival of erosion control plantings. Monitor effectiveness of protection of site quality and sediment delivery.

BIG QUILCENE PRESCRIPTION #6.

Resource Sensitivity Number: CMR #22 Segment S10

Situation Sentence for the Area (from causal mechanism report):

Coarse sediment delivered in (from) past debris slides in Geomorphic Unit (MWMU) #36 and associated with USFS Roads 2700-000, -020, have been delivered and is filling pools in this segment.

Triggering Mechanism (from causal mechanism report):

Alteration of natural drainage patterns and road drainage.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Road drainage has been diverted to fills on the outslope at drainage crossings. Old debris slides occurred at these crossings. (WIN # 200, 290,298)

Management Objective:

Prevent "accelerated" delivery of sediment from roads.

Recommendation:

1. Assess road drainage (culvert spacing, size, location, inlet grade/size) along USFS Road 2700-070.
2. Through road maintenance or reconstruction, change outslope grade at crossings to inslope.

Restoration/Enhancement/Monitoring:

Slide area is recovering naturally, no treatment necessary.

Monitor function of road drainage during a storm event to assure capacity is adequate.

BIG QUILCENE PRESCRIPTION #7.

Resource Sensitivity Number: CMR's #19, 23, 24, 27, 28, 48, 51, and 52 Segments S10-S2 (Townsend); 21-38(Big Quilcene)

Situation Sentence for the Area (from causal mechanism report):

Unstable sidecast along USFS Road 2700-000 and 2740-060 and in Geomorphic Unit (MWMU) #36 will deliver coarse and fine sediment to all listed segments, reducing pools and affecting fish spawning, holding, and rearing habitat, water quality (turbidity), and road use.

Triggering Mechanism (from causal mechanism report):

Unstable road sidecast and low compaction in road prism on steep slopes >55%. Site noted by CMR #28 has a high subsurface water table, as well.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Tension cracks and sidecast movement downslope are common features along USFS Road 2700 and 2740-060. These roads have had a history of roadfill failures and settlement. Sediment delivery hazard is the highest in areas adjacent to stream crossings and where the road parallels a stream on a slope greater than 65% and concave below the road. See Geotechnical Report USFS RD 27, Wilson, 1994. S. Wilson describes site by site unstable locations. (WIN # 124,126, 128,130,132,134,137,138,141,144,256)

Management Objective:

Prevent "acceleration" of delivered sediment to stream channels from road sidecast failures.

Recommendations:

1. Remove high hazard road sidecast as identified by Olympic NF WIN Inventory or qualified slope stability professional. Dispose in stable location. Reconstruction may be necessary if road width becomes limited.
2. Maintain road drainage so that water is not diverted to unstable fills.
3. See Geotechnical Report, S. Wilson, 1994.

Technical rationale:

Numerous slides have occurred along USFS Road 2700-000 and 2740-060 due to unstable sidecast. Mass Wasting Inventory shows a 11% increase in sliding over natural in Geomorphic Unit #36. This increase in slides is due to sidecast "balanced" road design common to roads built in the 1950 and 1960's'.

Restoration/Enhancement/Monitoring:

After sidecast removal:

1. Monitor the number of slides occurring after treatment. Has the number decreased over the rate in the mass wasting inventory? Are these slides being delivered to a watercourse?
2. Monitor revegetation after removal. Is the revegetation treatment after sidecast removal surviving and will this treatment contribute to long term revegetation? Is revegetation controlling surface erosion during re-establishment?

BIG QUILCENE PRESCRIPTION # 8.

Resource Sensitivity Number: CMR #25 Segments S7, S8

Situation Sentence for the Area (from causal mechanism report):

Fine sediment is being delivered to Segments 7 & 8 by unstable road cut in Geomorphic Unit (MWMU) #36 at the USFS Road 2750 crossing of Townsend Creek which is filling pools and affecting fish spawning, rearing, and holding habitat, as well as affecting water quality (turbidity).

Triggering Mechanism (from causal mechanism report):

Road cut is too steep for soil materials natural angle of repose. Soil material is a deep deposit of uncohesive glacial fluvial sands/gravels over glacial till. These uncohesive materials are not stable at 1:1 cut ratios.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Roadcut ravel and sloughing has occurred at this site as long as district personnel can recall. A gabion wall was constructed to retain material from falling into roadway. This wall is catching most of the erosion but some fines continue to wash into Townsend Creek during storms.

Management Objective:

Prevent acceleration of sediment delivered to Townsend Creek.

Recommendation:

1. Routine maintenance to assure continued function and integrity of the gabion walls in needed to continue protection of sedimentation delivery to Townsend Creek.
2. Assess whether "winterizing" with straw bales as temporary sediment traps during storms as practical. This would only be appropriate if these bales could be monitored and maintained during the winter months.
3. Assess road drainage for long term remediation through "reconstruction" possibilities. Is it possible to elevate the crossing to drain road away from crossing to relief culverts which drain into vegetation prior to entering Townsend Creek.

Technical rationale:

Uncohesive coarse textured soils require cutslope ratios of less than 2:1 to be stable which is impractical on steep slopes. Coarse textured soils are difficult to revegetate when unstable. In order to reduce sediment, structural capture of materials and maintenance is the most practical method of reducing delivery.

Restoration/Enhancement/Monitoring:

1. Intensive Bioengineering with well adapted species for coarse textures soils with routine monitoring and maintenance to re-establish failed areas may over time revegetate this road cut.

2. Above/below turbidity monitoring during storm events to assess the relative contribution of sediment from this site. The result of this monitoring would assist in benefit/cost analysis on erosion control treatments.

BIG QUILCENE PRESCRIPTION # 9.

Resource Sensitivity Number: CMR #33 Segments O10-O13

Situation Sentence for the Area (from causal mechanism report):

Sidecast failure of USFS Road 2740-110 in Geomorphic Unit (MWMU) #32 and current surface erosion of bare soil (WIN #179) from this slide is delivering fine sediment to these segments.

This is affecting water quality (turbidity) as well as downstream fish holding, rearing, and spawning habitat.

Triggering Mechanism (from causal mechanism report):

Sidecast road construction on slopes greater 55%.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

WIN Inventory, Spring 1994 by Scott Hagerty, Soil Scientist noted that this slide is revegetating and recovering. (WIN# 179)

Management Objective:

Prevent "acceleration" of sediment delivery from management activities such as slides from roads.

Recommendations:

Conduct road maintenance such that road drainage does not flow onto the old slide area. Avoid grading material over the side as well. Additional drainage or sidecast maintenance materials to this recovering site will delay or limit recovery.

Technical rationale:

Water or soils flowing over bare, or partially vegetated steep slopes will continue to erode soils and small germinating plants reducing vegetative recovery.

Restoration/Enhancement/Monitoring:

Monitor natural revegetation of this site until site is completely recovered. Initiate appropriate intervention if downward trend is noted.

BIG QUILCENE PRESCRIPTION #10.

Resource Sensitivity Number: CMR #36 and CMR #37 Segments P1-P4

Situation Sentence for the Area (from causal mechanism report):

CMR #35, 36, 37 and #39: Surface and mass erosion from numerous old road/landing failures and broadcast burning of harvest units along USFS Roads 2740-000, 2650-000, 2650-055 and 2650-090 and road stacking of USFS Road 2650-000,-090 and 2650-000,-055 in Geomorphic Unit (MWMU) #36 and #26, have reduced site quality and are delivering sediment to these segments.

Triggering Mechanism (from causal mechanism report):

Removal of vegetative cover and root strength, sidecast construction of roads/landings, increasing hydrologic response, and inadequate road drainage along stacked roads creates a higher erosive force. Steep roadcuts fill ditches with ravel Removal of vegetative cover and root strength increasing erosivity. Failures from sidecast constructed landings/roads displacing topsoil and removing vegetation. Road "stacking" and roads located through soils with a seasonal water table alter natural drainage patterns. Water naturally dispersed through subsurface drains is captured by road ditches and drains through culverts onto a smaller area which causing road water to divert over fills and to erode fillslopes.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Numerous WIN sites were noted during WIN Inventory, Spring 1994 by S.Hagerty. The area between roads 2740 and 2740-090 just uproad from the "Y" junction has had nearly 90% of the vegetation removed through rill and gully erosion. Approximately 30% of a 30 acre(approx.)-clearcut below USFS Road 2740 is in bare soil and actively eroding.

Management Objective:

Maintain and avoid degradation of the basic properties that contribute to site quality e.g. soil fertility/tilth.
Prevent "acceleration" of delivered sediment from management activities.

Recommendations:

1. Remove remaining unstable sidecast and contour road edge back to a stable angle e.g. do not leave an overhanging edge.
2. Utilizing road maintenance, engineering and watershed expertise, prepare a comprehensive plan that addresses road drainage, road maintenance, and revegetation treatments. This is a complex area which requires treating the cumulative causes before the symptom to be successful. Revegetation may require repeated treatments for recovery.

Technical rationale:

Repeated failures of sidecast and accelerated runoff from roads have removed vegetation and kept these areas disturbed. Over 50% of the surface soil has been removed which exceeds Regional standards for detrimental conditions to soil quality. Estimate acres of detrimental condition is 20 acres.

Restoration/Enhancement/Monitoring:

1. Stabilizing soil movement and dispersing drainage from the first 1/8 mile of Road 2740-090 can not be done and retain road width for vehicular access. Obliteration will bring the most complete remediation.
2. Annual monitoring and re-establishment maintenance of bioengineering work will be necessary to recover highly eroded areas between the two roads and in the clearcut immediately below Road 2740.

BIG QUILCENE PRESCRIPTION #11.

Resource Sensitivity Number: CMR's #38, 41, 42, and 43 Segments 01-09

Situation Sentence for the Area (from causal mechanism report):

CMR 38,41,42,43: Past and current mass wasting events associated with USFS Roads 2650-000,-050,-055, in Geomorphic Unit (MWMU) #77 and #36 are delivering coarse and fine sediments to these segments and has degraded site quality. These processes are producing local sediment accumulation behind LWD and affecting adult rainbow trout holding and summer rearing cover and reducing water quality.

(These events have provided a chronic condition for many years (S. Ricketts, pers. comm.).

Triggering Mechanism (from causal mechanism report):

Roads located on unstable slopes. Accelerated runoff as a result of "stacked" roads. Sidecast constructed roads on slopes greater than 55% slopes. Road drainage diverted to the outslope and onto hydrologically sensitive 0 and 1st order channels.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

WIN Inventory, Spring 1994 by Scott Hagerty. WIN # 176, 177 are examples. Road diversion onto 0 and 1st order channels caused several of them to slide carrying road fill downslope. Debris fall from steep roadcuts fill ditches reducing drainage function. This area underwent a rain-on-snow event Winter, 1993 and Geomorphic Unit #77 showed low resilience to this storm.

Management Objective:

Prevent "acceleration" of delivered sediment from management activities.

Recommendations:

1. Utilizing road maintenance, engineering and watershed expertise, prepare a comprehensive plan that addresses road drainage, road maintenance, and revegetation treatments. This is a complex area which requires treating the cumulative causes before the symptom to be successful. Revegetation may require repeated treatments for recovery.

Some suggested options for road management are:

- a. install higher density of relief culverts and maintain road at Level 3 (keep debris removed from ditches/inslope).
- b. winterize with waterbars frequently spaced, maintain drainage to the inslope in convergent areas (#77) and to the outslope (except on sidecast fill) in divergent areas (#36).and close road to winter travel to protect their function.
2. No additional road density should be added (stacked) in the convergent areas.
3. Stacked roads should be eliminated in convergent areas, Geomorphic Units #77.

Technical rationale:

Drainage capture by road networks alters hillslope hydrology and can cause concentration of water on convergent landforms. Wimple, 1993, found that road networks can cause as much as a 40% increase in first order stream length by roads extending the hydrologic network. Convergent areas with many 0 and 1st order channels are more sensitive to increases in flow, making them more prone to shallow rapid slope failures.

Restoration/Enhancement/Monitoring:

Annual monitoring as soon as access is possible in the spring to assess improvements to road drainage. The comprehensive road maintenance plan should be adjusted if necessary.

BIG QUILCENE PRESCRIPTION #12.

Resource Sensitivity Number: CMR #47 and 49, Segments 28-38

Situation Sentence for the Area (from causal mechanism report):

Coarse and fine sediment from road drainage and sidecast failures (WIN #211,212,183,209,210) at road crossings of Class 3 streams from USFS Road 2750 (Jolly Creek) and USFS Road 2740-060 in Geomorphic Units (MWMU) #35 and 36 is filling pools and affecting brook and rainbow trout holding, rearing, and spawning habitat.

Triggering Mechanism (from causal mechanism report):

Unstable sidecast, diversion of road drainage onto fills, inadequate routing of road drainage

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

WIN Inventory, Spring 1994 by Scott Hagerty. WIN #211,212 are worsening and trends on WIN#'s 183, 209, and 210 are remaining the same.

Management Objective:

Prevent "acceleration" of sediment delivered to stream channels.

Recommendation:

1. Remove all high hazard unstable sidecast and recontour outer road edge to a convex shape. Revegetate.
2. Revegetate old debris slide tracks.
3. Assess road drainage diversion potential to the outslope and culvert location/condition/size. Reconstruct or maintain road segments to deliver road drainage through ditches not over fills.

Technical rationale:

Road drainage diverted to unconsolidated fills on steep slopes increases the possibility of sidecast failure or fill erosion in drainageways as observed during the WIN inventory. Removal of unstable sidecast reduces volume of fill that is available for sliding and delivery to watercourses. Revegetation reduces surface erosion on bare disturbed soils.

Restoration/Enhancement/Monitoring:

1. Monitor road drainage function after treatment. Make additional improvements or adjustments to assure road drainage is adequately dispersed and not causing impacts.
2. Monitor revegetation treatments for 2-5 years following treatment to assure vegetation is re-establishing.

BIG QUILCENE PRESCRIPTION #13.

Resource Sensitivity Number: CMR's #50, 57, 63, 64 and 65, Segments 28-33, 7-15, 16-19

Situation Sentence for the Area (from causal mechanism report):

CMR #50: Coarse and fine sediment from debris slides and chronic erosion(WIN 261) in Mass Wasting Unit #78 from removal of vegetation by clearcut harvest and outsloped road drainage on unstable slopes (debris tracks) is filling pools and affecting rainbow trout spawning, holding and rearing habitat.

CMR #63: Coarse and fine sediment from existing and mass surface erosion from Geomorphic Units (MWMU) # 78 and 77 because of harvest and road stacking on hydrologically responsive areas, are being delivered to these segments, reducing pool volume. This is affecting incubation habitat for salmon and steelhead, and reducing low flow rearing areas.

CMR #65: Coarse and fine sediment from sidecast failure from road 2620 (Win #103 and 104) and cutslope (WIN #103) mass erosion at the road crossing of Elbow Creek is routing through these segments reducing pool volume. This is affecting incubation habitat for salmon and steelhead, and reducing low flow rearing area in Segment 8 and further downstream.

SUGGEST ONE: CMR's #50, 63, 64, 65, 57 Coarse and fine sediment from sidecast failures, debris slides in harvest units and from roads in hydrologically responsive areas, Geomorphic Units (MWMU) #77 and #78, are being delivered, reducing pool volume and affecting rainbow trout spawning, holding and rearing habitat in Segments 28-33 and in segments 7-15, reducing incubation habitat and low flow rearing areas for salmon and steelhead.

Triggering Mechanism (from causal mechanism report):

Removal of vegetation cover, stacked roads, and high density of roads in hydrologically convergent areas increases runoff (stream and overland) surpassing road drainage capacity particularly during rain-on-snow events. Reducing root strength on steep slopes prone to mass movement.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Both the aerial photo inventory of mass wasting and the WIN inventory, Spring 1994 by Scott Hagerty show numerous debris slides and flows activated by roads and harvest in Geomorphic Units #77 and 78. The rate of increase over natural is over 2 times and frequency of extensive slides has changed historically from every 100-200 years to 2-10 years. Fans at the mouths of tributaries to Big Quilcene are evidence that large amounts of sediment have been delivered over time.

An historic review of the photo record shows that One and One-half Mile Creek, began to "unravel" in the early 60's after 35-40% of the basin was clearcut/roaded. There has been no recovery since this date with major debris flow events rescouring shown in 1975 and in 1982 photos, again in 1993. This response is representative of what can occur in other Geomorphic Unit #77 in the watershed.

Recommendations:

Include Geomorphic Units #77 and #78 in Riparian Reserve areas.

VEGETATION REMOVAL GUIDELINES:

1. No vegetation removal in Geomorphic Units #78.
2. No clearcut harvest in Geomorphic Unit #77 with standard no harvest reserves along any channel or spring, intermittent or ephemeral. Thinning and selection cuts should be limited to leaving 70% crown cover over 90% of the convergent area including ridgelines with shallow soils. Variations to this recommendation must be supported by field review/analysis by a hydrologist and soil scientist/geologist.
3. Where prior removal of vegetation in GU 77/78 exceeds the above, and timber stand improvement thinning is necessary, prescriptions should be developed on site analysis by a hydrologist and soil scientist/geologist. There are too many variables for a one standard prescription. Factors to be addressed are: distribution of less than 15 year old plantations and roads and their relative contribution to increasing runoff; risk of sediment delivery from temporarily reducing stand area that was in an early stage of hydrologic maturity. A "starting point" may be: No more than 30% of the area thinned to a crown cover of 50%. Additional thinning might be considered as crowns reach 70% cover.

ROAD MANAGEMENT:**Existing Roads:**

1. Evaluate USFS Road 2620 and 2650 for reconstruction or decommissioning to eliminate contributions of sediment by road failures (sidecast, road drainage, locations on bedrock hollows).
2. Decommission USFS Roads 2620-070, -060 and 2650-050, -055, -090.
3. With engineering, road maintenance, and watershed expertise, prepare a comprehensive plan that directs reconstruction and maintenance to disperse and route road drainage to the inslope with runoff to the more stable areas of the landscape (if possible). This plan should examine alternatives such as installation of relief culverts at a higher density, more frequent ditch and inlet cleanout, winterizing with waterbars and winter access closures to protect their function, removal of unstable sidecast, regrading to inslope drains, and culvert condition and adequacy for passing peak flows.

New Roads:

Additional roads should be avoided. It is difficult to meet Aquatic Conservation Strategy with the best methods in these Geomorphic Units.

Management Objective:

Prevent "acceleration" of delivered sediment (to fish habitat and which degrades water quality.)

Technical rationale:

Roads capture subsurface water and route stormwater differently than an unroaded slope. Convergent areas with many 0 and 1st order channels are more sensitive to increases in flow, making them more prone to shallow rapid slope failures.

Response to harvest and roading of these geomorphic units demonstrate their sensitivity to hydrologic events. Observing several levels of harvest and roading in the various GU's in the watershed, it remains difficult to recommend a maximum rate of harvest or roading that these landscapes can "Handle" without increasing mass wasting substantially over historic rate. Two times the natural rate in debris slides were noted at 35 - 40% clearcut harvest level in Mile 1/2 Creek drainage which is representative of Geomorphic Unit 77. The cumulative effect of concentration of road drainage contributed to this response as well. 35% of the basin was harvested at once which leaves no opportunity to observe at what rate of vegetation removal the basin may have remained with its natural rate. The maximum rate of vegetation removal was set using the following rationale: percent of area in Geomorphic Unit 77 that is in "inner gorge"/debris track is approximately 70-90 percent. Inner gorges and debris tracks are known for instability and landslides have been observed immediately after vegetation removal.

Mass wasting events in these units directly affect habitats for resident and anadromous fishes and delivers suspended sediment directly to hatchery water intakes in segment 3.

Restoration/Enhancement/Monitoring:

1. Geomorphic Units #77 and #78 should be targeted for reducing road density through obliteration. Drainage dispersal is difficult and endhaul to an adequate disposal site may be necessary to avoid additional mass wasting.
2. Evaluate the volume of material removed from an unstable location and compare the resultant reduction of slide material after road obliteration. Has road delivered sediment been reduced?
3. Annual monitoring as soon as access is possible in the spring to assess improvement to road drainage. The comprehensive road maintenance plan should be adjusted if necessary.
4. After harvest or thinning, evaluate adequacy of road drainage function and indication of erosion/mass wasting from storm events. Adjust prescription if necessary to meet Aquatic Conservation Strategy.

BIG QUILCENE PRESCRIPTION #14.

Resource Sensitivity Number: CMR #53 Segments 21-27

Situation Sentence for the Area (from causal mechanism report)

Fine sedimentation created by unstable road cuts at the USFS Road 2740-000/Big Quilcene crossing requires routine maintenance that increases sedimentation to Segment #22. This is filling pools and affecting rainbow trout spawning, holding, and rearing habitat as well as water quality.

Triggering Mechanism (from causal mechanism report):

Roadcut is too steep for soil materials natural angle of repose. Soil material is a deep desposit of uncohesive glacial fluvial sands/gravels over glacial till. These uncohesive materials are not stable at 1: 1 cut ratios.

Rule Call for Management Prescriptions (from causal mechanism report:) Prevent or Avoid.

Field Observations:

Roadcut ravel and sloughing has occurred chronically, at this site. A gabion wall was constructed to retain material from falling into roadway. This wall is catching most of the erosion but some fines continue to wash into the Big Quilcene River immediately above the municipal water diversion.

Management Objective:

Prevent acceleration of sediment delivered to Big Quilcene River.

Recommendation:

1. Routine removal of material deposited behind and onto the gabion walls in needed to continue the retention of eroding materials and limit delivery to Big Quilcene River.
2. Assess whether "winterizing" with straw bales as temporary sediment traps during storms is practical. Bales could be monitored and maintained during the winter months.
3. Assess road drainage for long term remediation through "reconstruction". It is possible to elevate the crossing to drain road away from crossing to relief culverts which drain into vegetation prior to entering Big Quilcene River.

Technical rationale:

Uncohesive coarse textured soils require cutslope ratios of less than 2:1 to be stable which is impractical on steep slopes. Coarse textured soils are difficult to impossible to revegetate when unstable. In order to reduce sediment, structural capture of materials and maintenance is the most practical method of reducing delivery.

Restoration/Enhancement/Monitoring:

1. Intensive Bioengineering with well adapted species for coarse textures soils with routine monitoring and maintenance to re-establish failed areas may over time revegetate this road cut.
2. Above/below turbidity monitoring during storm events to assess the relative contribution of sediment from this site. The result of this monitoring would assist in benefit/cost analysis on erosion control treatments.

BIG QUILCENE PRESCRIPTION #15.

Resource Sensitivity Number: CMR's #58, 60, 61, 62 and 66, Segments 16-19, 7-10

Situation Sentence for the Area (from causal mechanism report):

CMR #58: Coarse and fine sediment is being delivered (WIN 279, 260, 285,295,291,296) to Segments 16-19 by shallow rapid debris slides from Geomorphic Units (MWMU) #90. These units have a highly unstable slope and are responsive to storm events and undercutting by stream action. Frequency of these events has increased by unstable road sidecast failures and diversion of road drainage onto unstable slopes from road 2620-100 (decommissioned 1993).

CMR #60: Fine sediment is being delivered to Segments 16-19 by debris slides from upslope intermittent channels in Geomorphic Unit (MWMU) #90, diverting road drainage on USFS Road 2700-040, which is increasing turbidity and filling pools downstream. This is affecting rainbow trout spawning, holding and rearing habitat, and water quality.

CMR #66: Coarse and fine sediment from mass wasting and surface erosion of unstable soils below Highway 101 in Geomorphic Unit (MWMU) #90 is routing through these segments, reducing pool volume. This is affecting incubation habitat for salmon and steelhead, and reducing low flow rearing area in Segment 8 and further downstream.

Triggering Mechanism (from causal mechanism report):

Stream action at toeslopes causing oversteepening and unstable slopes, roads drainage flows into many 0 and 1st order channels that have high sensitivity to increased flow.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Win Inventory, Spring 1994 by Scott Hagerty. (Win # 279,266,282,295,291,296, and Hwy 101-ES.) Roads have increased slides by 2 times over the natural rate.

Mass Wasting Inventory indicates that debris slides are common (every 25-50 years) process even prior to roading or harvest. Slides are initiated in mature stands midslope along outside bends of the channel and in areas where wildfires had removed vegetation initiating gully erosion and slides.

These areas have direct delivery to the Big Quilcene mainstem and fisheries habitat. In Winter 1993, several slides delivered sediment fans to resident fish habitat in this river reach.

Recommendation:

Incorporate Geomorphic Unit #90 into Riparian Reserve areas, ROD (USDI/USDA, 1994).

VEGETATION MANAGEMENT:

1. No vegetation should be removed in channels or springs, ephemeral or intermittent, perennial per standards in ROD (USDI/USDA, 1994). No clearcut harvest. Extensive Salvage, Thinning, Selection, and Partial cut harvest prescriptions should be guided by a geotechnical analysis.
2. Special attention for geotechnical analysis prior to harvest on slopes below USFS Road 2620-100 (obliterated). Old road sidecast has been creeping downslope for over 20 years. Rate of movement has been slowed by increasing root strength as stands mature. Harvest of these stands in some areas where sidecast is deep and supported by rotting debris could initiate slides.

ROAD MANAGEMENT:

1. Evaluate USFS Road 2700-040 for reducing sedimentation to Big Quilcene River and to limit channel confinement by road prism OR decommission to eliminate channel confinement.
2. No roads should be constructed. Stable full bench roads designs are difficult to construct without retaining walls. Roads along toeslopes constrict the stream which prevents desired floodplain function or in-channel sediment storage. Riparian vegetation is also impeded.

Management Objective:

Prevent "Acceleration" of delivered sediment.

Technical rationale:

Slopes in Geomorphic Unit 90 are near their angle of repose, naturally. These slopes are kept at a dynamic stability / instability level by stream action undercutting the slope. Roads cut into these "oversteepened" slopes increase the slope angle to an unstable angle, initiating roadcut headcutting and roadfill failures. Slope steepness (>70%), concave slope configuration, and stream density contribute to a highly efficient delivery of sediment. The photo record as well as observations on like landforms in adjacent watersheds indicate that slight alterations of vegetation and roads accelerate mass wasting. The mass wasting inventory for the Big Quilcene Watershed Analysis found an increase of slides from natural by 2 times the rate and from every 50 years to every 5-20 years in frequency. The 1939 photography shows active gully erosion and debris slides where vegetation had been partially removed by the Wildfire of 1930.

Restoration/Enhancement/Monitoring:

The slide below Highway 101 is in recovery. Additional bioengineering would aid in speeding up re-establishment of vegetation on this site. This site has been a major contributor of sediment for over 50 years.

BIG QUILCENE PRESCRIPTION #16.

Resource Sensitivity Number: CMR #44

Situation Sentence for the Area (from causal mechanism report):

Soil material is being removed from slopes by gully and rill erosion between roads 2650 and 2650-050, and occurring from road stacking and outsloped road drainage. This is increasing maintenance and affecting road use.

Triggering Mechanism (from causal mechanism report):

Road stacking and road drainage.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Debris from roads stacked on steep slopes fills drainage ditches and plugs culverts, causing erosion of the road surface and fill as a result of rerouted water flow.

Voluntary Prescriptions:

1. Assess requirements and decommission roads when possible.
2. Upgrade old roads by removing unstable sidecast and upgrade drainage structures to current design standards.
3. Assess road drainage for diversion capacity, and upgrade if necessary. Drainage structures must be maintained annually.
4. Road maintenance will be done with sufficient frequency to keep drainage structures functioning as designed.

Management Objective:

Reduce the road maintenance problems from gully and rill erosion.

Technical rationale:

Drainage which results in sheet flow across an dirt road surface causes erosion of the road surface and fill.

Drainage capture by road networks alters hillslope hydrology and can cause concentration of water on convergent landforms. Whimple 1993, found that road networks can cause as much as a 40% increase in first order stream length by roads extending the hydrologic network.

Voluntary Enhancement/Monitoring:

BIG QUILCENE PRESCRIPTION #17.

Resource Sensitivity Number: CMR #61 and #62.

Situation Sentence for the Area (from causal mechanism report):

CMR #61: Coarse and fine sediment from existing mass and surface erosion from Geomorphic Unit #90 on hydrologically responsive areas, are being delivered to road 2700-040 which also supports the diversion pipeline. This will reduce and erode the road prism, closing the road to travel, and causing possible loss of support to the pipeline, with resulting breaks in the line.

CMR #62: Mass wasting, associated with Geomorphic Units #90, is entering the river channel, and causing constriction of the channel. During peak flows, this is directing the stream flow against the bank supporting the road and water supply pipeline, causing bank cutting, and possible loss of the pipeline.

Triggering Mechanism (from causal mechanism report):

CMR's #61 and #62: Erosive roadcuts too steep to support vegetative cover. "Stacked*" roads with road drainage from top road increasing runoff to lower roadcut in hydrologically convergent areas. Stacked roads with road drainage eroding area between roads. Accelerated runoff from upper road as a result of stacked roads. Over-steepened road cuts (unstable).

*Road Stacking - multiple road prisms in close proximity on steep slopes that accelerate road drainage from one road to another.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Coarse sediment from intermittent streams between Segments 16 and 19 plugged culverts and blocked passage on the 2700-040 road in several locations during the December 1993 flood event. Several mass wasting events triggered by the December storm were carried into the river channel. One debris slide has constricted the river channel by more than half. Across from this slide the toe of the bank which supports the 2700-040 road is being eroded.

Prescriptions:

1. No vegetation removals on 70% or greater slopes on inner gorge slopes in MWMU #90. On hillslopes between 50-70% located upslope of >70% inner gorge slopes and harvest may occur following an on-site review by a slope stability expert. Refer to attached MWMU #26, #36 and #78 definition. Harvest on 50-70% slopes will be conducted in such a way that delivery of coarse and fine sediment to the stream channel is prevented.
2. Any new road construction proposed in #90 will be designed and field reviewed by a professional engineer.
3. Assess requirements and decommission roads when possible.

Management Objective:

Avoid acceleration of mass wasting rate in MWMU #90.

Technical rationale:

Slopes in this Geomorphic Unit are near their angle of repose, naturally, roads cut into the slopes in effect, increase this angle initiating roadcut headcutting and roadfill failures.

Road produced sediment has nearly direct delivery to the channel.

BIG QUILCENE PRESCRIPTION #18.

Resource Sensitivity Number: CMR #92 H1-Spencer Creek BH-1 To BH-3 (Hydrology)

Situation Sentence for the Area (from causal mechanism report):

Mass wasting from peak flows undercuts banks which delivers coarse/fine sediments. Bank erosion causing slopes between topographic break and stream to be unstable. Further reduction of root strength by removing vegetation, or roading, will increase sediment delivery and routing. The effects are pool filling, which affects spawning and rearing habitat.

Triggering Mechanism (from causal mechanism report):

Channel Bank Scour, roading, and riparian vegetation removal.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid

Field Observations:

Channel Module observed bank erosion/toe slope erosion, and fresh coarse sediment deposition and movement (active bars). Fresh wood accumulation from bank failure.

Prescriptions:

Hydrologic maturity within the ROS Zone (between elev.) shall be maintained at % or greater.

Management Objective:

Maintain a distribution of vegetation age classes and densities that will maintain water storage (snow pack) at or below current level.

Technical Rationale:

By maintaining or reducing the area of the sub-basin in young forest, increased delivery of water to stream channels during rain-on-snow events is ameliorated.

Recommendations for Enhancement/Monitoring:

Install flow or crest gauge. Annual air photo monitoring of percent of ROS zone in young forest (<10 years).

BIG QUILCENE PRESCRIPTION #19.

Resource Sensitivity Number: CMR #92, MWMU #1: Spencer Creek Channel Segments BH-2 and 3 hillslopes 45% and greater.

Situation Sentence for the Area (from causal mechanism report):

Mass wasting from peak flows undercuts banks which delivers coarse/fine sediments. Bank erosion causing slopes between topographic break and stream to be unstable. Further reduction of root strength by removing vegetation, or roading, will increase sediment delivery and routing. The effects are pool filling, which affects spawning and rearing habitat.

Triggering Mechanism (from causal mechanism report):

Channel Bank Scour, roading, and riparian vegetation removal.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid

Field Observations:

Channel Module observed bank erosion/toe slope erosion, and fresh coarse sediment deposition and movement (active bars). Fresh wood accumulation from bank failure.

Field Observations in the upper portion of BH-2 confirm direct coarse and fine sediment delivery to the channel from bank erosion.

South Side: Translational slide from mid-slope road construction, soil creep, pistol butt and jack-strawed trees.

Prescriptions:

South Side of Stream Channel:

No new road construction or vegetation removal on slopes between highway 101 and the stream channel.

North Side of Stream Channel:

No road construction or vegetation removal within 200' slope distance of channel.

Management Objective:

Maintain or increase root strength on hillslopes between upper topographic break and stream.

Technical Rationale:

Road construction and vegetation removal reduces root strength, which reduces the effective soil cohesion on the hillslope. Ward et al. 19__?

Monitoring Recommendations:

Measure fine sediment deposition in pools. Lisle 1992.

BIG QUILCENE PRESCRIPTION #20.

Resource Sensitivity Number: CMR #93 Segments BH-10 to BH-16 (SHC Spencer Creek) Channel segments 1-8.

Situation Sentence for the Area (from causal mechanism report):

Loss of riparian vegetation from harvest activities, powerline corridor, residential development and highway corridor in Riparian Units 10, 11, 13, 15, and 16, has resulted in below target LWD recruitment potential, affecting fish spawning and rearing habitat, as well as sediment routing.

Triggering Mechanism (from causal mechanism report):

Removal of riparian vegetation by residential development, powerlines, highway and harvest.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Riparian vegetation removal has resulted in mixed/young riparian canopy. Highway 101 is in the RMZ.

Prescriptions:

1. No harvest of conifer species within 66 horizontal feet of the ordinary high-water mark of the stream.
2. Hardwood harvest within 66 horizontal feet of the ordinary high water mark of the stream shall be for conifer release only. Monitoring of success will be required if Option 2 is chosen.

Management Objective:

Technical rationale:

Assumed 95% LWD is recruited within 66 feet (horizontal distance) of the stream. Murphy and Koski 1989. Removal/reduction of deciduous canopy benefits shade intolerant conifer.

Recommendations for Enhancement/Monitoring:

1. Placement of large stable conifer LWD in appropriate reaches. Martin Fox 1994. Monitor conifer release from deciduous removal within the 66 foot RMZ. Hardwood removals (within 66 feet) of the stream should be monitored for release success, success \leq 15% mortality to existing conifer.
2. Voluntary Enhancement: Plant appropriate conifer species to promote large conifer in riparian management zone.

BIG QUILCENE PRESCRIPTION #21.

Resource Sensitivity Number: CMR #94 Segments B-1 to B-6 (SHC Jackson and Marple Creeks).

Situation Sentence for the Area (from causal mechanism report):

Loss of riparian vegetation from harvest activities, and powerline corridor maintenance in Riparian Units 19, 22, and 23 has resulted in below target LWD recruitment potential, affecting fish spawning and rearing habitat, as well as sediment routing.

Triggering Mechanism (from causal mechanism report):

Removal of riparian vegetation by powerline maintenance, and harvest activities.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Riparian module observed 2 12" diameter LWD pieces in 1000 feet of stream. Channel module observed little wood in the active stream channel.

Prescriptions:

1. No harvest of conifer species within 66 horizontal feet of the ordinary high-water mark of the stream.
2. Hardwood harvest within 66 horizontal feet of the ordinary high water mark of the stream shall be for conifer release only. Monitoring of success will be required if Option 2 is chosen.
3. Minority opinion requests a review of the technical literature regarding LWD recruitment.

Management Objective:

Encourage large conifer in riparian management zone.

Technical rationale:

Assumed 95% LWD is recruited within 66 feet (horizontal distance) of the stream. Murphy and Koski 1989. Removal/reduction of deciduous canopy benefits shade intolerant conifer.

Recommendations for Enhancement/Monitoring:

Voluntary Enhancement: Placement of large stable conifer LWD in appropriate reaches. Martin Fox 1994.

Monitor conifer release from deciduous removal within the 66 foot RMZ. Hardwood removals (within 66 feet) of the stream should be monitored for release success, success \leq 15% mortality to existing conifer.

BIG QUILCENE PRESCRIPTION #22.

Resource Sensitivity Number: CMR #95 Segments BI-1 (SHC Jackson and Marple Creeks).

Situation Sentence for the Area (from causal mechanism report):

Cover loss from shoreline hardening, loss of riparian vegetation and nutrient increase from failed septic systems along BI-1, could affect coho rearing and spawning habitat, and chum spawning habitat.

Triggering Mechanism (from causal mechanism report):

Residential development and removal of vegetation.

Rule Call for Management Prescriptions (from causal mechanism report): Prevent or Avoid.

Field Observations:

Channel module observed extensive areas of bank erosion, residences encroaching on stream, bank hardening, see notes of Michelle Reba. Algae blooms observed on north side of channel.

Voluntary Prescriptions:

Shoreline Hardening:

1. Promote growth of woody shrubs and trees on channel banks.
2. Promote replacement of bank hardening materials with bioengineering techniques.

Riparian Vegetation:

1. Maintain adequate riparian zones in undeveloped areas.
2. Promote the use of native vegetation.

Nutrient Increase:

1. Property Owners, Jefferson County Health and the Department of Ecology should conduct a sanitary survey of the existing septic systems adjacent to the stream.
2. Prevent location of future septic systems in floodplain.

Management Objective:

Improve instream and riparian functions.

Technical rationale:

Direct discharge of untreated domestic waste to waters of the State is not permitted under RCW 90.48 Water Pollution Control Act.

Recommendations for Enhancement/Monitoring:

Voluntary Enhancement:

1. Placement of large stable conifer LWD in appropriate reaches. Martin Fox 1994. Monitor conifer release from deciduous removal within the 66 foot RMZ. Hardwood removals (within 66 feet) of the stream should be monitored for release success, success \leq 15% mortality to existing conifer.
2. Plant appropriate conifer species to promote large conifer in riparian management zone.

BIG QUILCENE PRESCRIPTION #23.

Resource Sensitivity Number: CMR #96 Segments BI-1, BI-2 and BI-3 (SHC Jackson and Marple Creeks).

Situation Sentence for the Area (from causal mechanism report):

Coarse and fine sediment from MWMU #78 & #77, from unstable slopes and unstable road sidecast, as well as road drainage diversions, have delivered to Jackson and Marple Creeks, filling pools, and altering LWD structures. This is affecting fish spawning, holding, and rearing habitat.

Triggering Mechanism (from causal mechanism report):

Alteration of hydrology:

1. Increases in water yield from even-age vegetation removal
2. Drainage capture and routing by road networks

Slope stability:

1. Removal of vegetation which reduces root strength on unstable slopes (inner gorge).
2. Sidecast constructed roads on concave slopes greater than 55%.
3. Road Construction on within MWMU #78 (inner gorge slopes) oversteepens cutslope beyond its natural angle of repose.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Historical review of aerial photography show that 40% clearcut harvest in Mile and 1/2 creek, (Map Unit #78), accelerated landslides 2.2 times over background.

ROS snow events in winter of 1993, caused road drainage diversions which eroded road fills and caused sidecast failures in Map Unit #77 (Marple and Jackson Creeks).

Management Objectives:

Prevent acceleration of landslides due to land management activities.

Prescriptions:

1. No sidecast on slopes >55%.
2. Any new road construction proposed in MWMU #77 and #78 will be field reviewed by a geotechnical expert.
3. In MWMU #78, No vegetation removals on 70% or greater slopes on inner-gorge slopes in MWMU #78. On hillslopes between 50-70% located upslope of >70% inner gorge slopes, harvest may occur following an on-site review by a slope stability expert. Refer to attached MWMU #78 definition. Harvest on 50-70% slopes will be conducted in such a way that delivery of coarse and fine sediment to the stream channel will be prevented.
4. In MWMU #77, some vegetation removal may occur upon review of geologist and hydrologist. These areas are of small extent and shall not significantly increase runoff to zero and first order channels.
5. For existing roads within MWMU #77 and #78 a road maintenance and abandonment plan will be required per WAC 222.24.050.

Voluntary Prescriptions:

1. Upgrade old roads by removing unstable sidecast and upgrade drainage structures to current design standards within MWMU #77 and #78.
2. Assess road drainage for potential for diversion, and upgrade if necessary. Drainage structures must be maintained annually.

3. Road maintenance will be done with sufficient frequency to keep drainage structures functioning as designed.
4. Attach MWMU Descriptions as per Joni's final description.

Technical rationale:

Loss of root strength from vegetation removal reduces effective soil cohesion and increases slope instability.

Road construction sidecast material is unstable on slopes >55%.

Drainage capture by road networks alters hillslope hydrology and can cause concentration of water on convergent landforms. Whimple 1993, found that road networks can cause as much as a 40% increase in first order stream length by roads extending the hydrologic network.

Hillslopes greater than 70% in inner gorges of MW #77 and #78 were formed by repeated debris flow events which undercut the toe-slope causing chronic and systematic hillslope failure over time. Reduction of root strength on these 70% slopes will accelerate the rate of hillslope failure.

Recommendations for Enhancement/Monitoring:

Monitoring: Map Unit #77:

1. Compliance monitoring to evaluate if harvest proposal was conducted as designed.
2. Immediately after harvest, and throughout a 15 year period, survey for signs of accelerated surface erosion and mass wasting indicators (tension cracks).
3. Set up ambient monitoring sites.

BIG QUILCENE PRESCRIPTION #24.

Resource Sensitivity Number: CMR #97 Segment BI-1 (SHC Jackson and Marple Creeks).

Situation Sentence for the Area (from causal mechanism report):

The aggradation of coarse sediment during peak flows, as well as an undersized culvert on the County road crossing Marple Creek, creates a high likelihood of the culvert washing out.

Triggering Mechanism (from causal mechanism report):

Alteration of hydrology:

1. Increases in water yield from even-age vegetation removal
2. Drainage capture and routing by road networks

Slope stability:

1. Removal of vegetation which reduces root strength on unstable slopes (inner gorge).
2. Sidecast constructed roads on concave slopes greater than 55%.
3. Road Construction on within MWMU #78 (inner gorge slopes) oversteepens cutslope beyond its natural angle of repose.

Culvert Design and Location:

Undersized culvert with little or no positive slope located in storage reach that has been artificially confined has accelerated aggradation of coarse material within culvert.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Gravel has filled the four foot diameter culvert within 18-24" of the top. Bank hardening directly upstream via residential development (foundations, bulkheads and riprap) has confined the channel.

Voluntary Prescriptions:

See prescriptions on CMR #96.

1. Replace culvert with structure capable of passing 100 year peak flow while handling expected aggradation to assure long-term use and public safety and fisheries habitat and protection.
2. Promote growth of woody shrubs and trees on channel banks.
3. Promote replacement of bank hardening materials with bioengineering techniques.

Management Objective:

Protect structural integrity of County road and fish habitat.

Technical rationale:

Further decreases in culvert capacity will cause stream to over-top County road and erode road fill, damaging the road, and blocking fish passage.

Bank hardening is causing accelerated streambed aggradation.

Recommendations for Enhancement/Monitoring:

Jefferson County Public Works should inspect and maintain existing culvert regularly until replacement is completed.

Voluntary Enhancement:

South bank below crossing provides an opportunity for approximately 300 feet of off-channel rearing habitat.

BIG QUILCENE PRESCRIPTION #25.

Resource Sensitivity Number: CMR #98 Segments (SHC Jackson and Marple Creeks).

Situation Sentence for the Area (from causal mechanism report):

Slight increases (4.2%) in the 2-year peak flow, from hydrologic immaturity within the basin, is causing streambank erosion and increases in sediment transport in these segments. This is affecting coho rearing and spawning habitat, and chum spawning habitat; as well as cutthroat spawning, rearing, and holding habitat.

Triggering Mechanism (from causal mechanism report):

Removal of vegetation and alteration of hydrology.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Same as #92

Voluntary Prescriptions:

Hydrologic maturity within the ROS Zone (between elev.) shall be maintained at % or greater.
Same as #92

Management Objective:

Same as #92

Technical rationale:

Same as #92

Recommendations for Enhancement/Monitoring:

BIG QUILCENE PRESCRIPTION #26.

Resource Sensitivity Number: CMR #88, Segments BJ and BF, NHC.

Situation Sentence for the Area (from causal mechanism report):

Nutrient and fecal coliform from septic fields located within flood plains have contributed to fecal coliform levels which threaten the shellfish harvest in Hood Canal.

Triggering Mechanism (from causal mechanism report):

Non-functioning septic drainfields.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Residential development with septic systems in floodplain.

Voluntary Prescriptions:

1. Existing septic systems within the floodplain should be re-engineered outside the floodplain.
2. Further residential development on the floodplain should be avoided.

Management Objective:

Eliminate human waste and nutrient inputs to Hood Canal from residential development on the floodplain of Indian George Creek.

Technical rationale:

Fecal Coliform levels have exceeded State Water Quality standards along lower Big Quilcene River, adjacent drainage systems, and shorelines. (Welch and Banks 1987).

Indian George Development is located within the 100 year floodplain.

Voluntary Enhancement/Monitoring:

Construction of Community sewer system and construction of upland system. Monitoring for fecal coliform and nutrient N and P loading within 100-year floodplain and tidelands.

BIG QUILCENE PRESCRIPTION #27.

Resource Sensitivity Number: CMR #85 MWMU #34H NHC (Unnamed tributary south of Indian George Creek in SE1/4, Sec 25, T27N, R2W).

Situation Sentence for the Area (from causal mechanism report):

Coarse and fine sediment from mass wasting in headlands (MWMU #34H) from removal of vegetation and or diverted road drainage on unstable soils, reduces possible coho spawning and incubation habitat, and possible resident trout spawning, rearing, and holding habitat. Mass wasting in (MWMU #34H) would directly impact intertidal marine resources, primarily oysters, by diminishing productivity.

Triggering Mechanism (from causal mechanism report):

Loss of root strength from roads and removal of vegetation, and diversion of road drainage to unstable slopes. Natural processes (wave action at headland toeslope, natural sliding), also contribute to slope instability.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Mass Wasting module observed indicators of low slope stability (jackstrawed and pistol butted trees in MWMU #34H)

Road outsloped at stream crossing is diverting drainage to unstable slopes.

Prescriptions:

Vegetation Removal:

On slopes greater than 70%, no vegetation removal. In segment BJ, these areas are of small extent adjacent to the channel and on steep breaks between channels below road comprising approximately 10-15% of the Map Unit.

Road Drainage Diversion:

Option 1: Construct Large waterbars, spaced approximately 50 feet, on private road accessing BPA Powerline and Devils Lake on +/- 17% grade south of the stream crossing in Segment BJ. Abandon road per WAC 222.22 Forest Practices Rules.

Option 2: Maintain road use by constructing open top box culverts, spaced approximately 50 feet, on private road accessing BPA Powerline and Devils Lake on +/- 17% grade south of the stream crossing in Segment BJ. These culverts should be inspected and maintained at least 4 times per year.

New road construction on MWMU #34H should be reviewed on-site by a geotechnical engineer.

Management Objective:

Prevent acceleration of mass-wasting in MWMU #34H above natural rates.

Technical rationale:

Slope stability/root strength Sidle and Swanston Ward et al.

On the steep grade south of the stream crossing, there is an erosion gully that is linked to improper road drainage.

Voluntary Enhancement/Monitoring:

BIG QUILCENE PRESCRIPTION #28.

Resource Sensitivity Number: CMR #86 Segment BG, NHC. (Tributaries between Spencer Creek and Big Quilcene).

Situation Sentence for the Area (from causal mechanism report):

Coarse and fine sediment from mass wasting from removal of vegetation and or diverted road drainage on unstable soils, within MWMU #78, as well as the potential sidecast failures within concave landforms associated with road 2730, will locally aggrade channel with coarse sediment and route fine and coarse sediment to coho and chum spawning and habitat, and possible resident trout spawning, rearing and holding habitat, and near-shore marine habitat.

Triggering Mechanism (from causal mechanism report):

Loss of root strength on unstable slopes, additional water from diverted road drainage, unstable sidecast of road 2730.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Unstable sidecast on road 2730 was noted in the WIN 1994.

Prescriptions:

1. No vegetation removals on 70% or greater slopes on inner-gorge slopes in MWMU #78. On hillslopes between 50-70% located upslope of >70% inner gorge slopes and harvest may occur following an on-site review by a slope stability expert. Refer to attached MWMU #78 definition. Harvest on 50-70% slopes will be conducted in such a way that delivery of coarse and fine sediment to the stream channel is prevented.
2. Road 2730 will be maintained so that road drainage will not be diverted to unstable sidecast.
3. Immediately below (50 feet) the 2730 road where sidecast has been deposited on slopes between 50-70%, harvest may occur following an on-site review by a slope stability expert.
4. Remove unstable sidecast from road 2730.

Management Objective:

Prevent acceleration of mass wasting on MWMU #78 above natural rates.

Technical rationale:

Root strength Ward et al.

Sidecast failures have been observed along road 2730 on slopes between 50-70%.

Voluntary Enhancement/Monitoring:

Compliance monitoring after sidecast removal to document slope stability hazard reduction and ensure revegetation of disturbed areas.

BIG QUILCENE PRESCRIPTION #29.

Resource Sensitivity Number: CMR #87 34H Segments BJ, BF, (NHC) (Tributaries between Spencer Creek and Big Quilcene

Situation Sentence for the Area (from causal mechanism report):

Coarse and fine sediment from mass wasting in (MWMU #34H) headlands, as a result of removal of vegetation and/or diverted road drainage on unstable soils, can lead to drainage failure and road fill erosion of the Linger Longer Road affecting the use of the road.

Triggering Mechanism (from causal mechanism report):

Loss of root strength on unstable slopes, additional water from diverted road drainage.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Shallow rapid landslides initiating from channel sideslopes above the Linger Longer road deposited coarse sediment and woody debris on the road and blocked drainage structures and damaged the road running surface during storm event in 1980s (M. Cronin pers. comm.)

Prescriptions:

1. No harvest on slopes greater than 70% in the inner gorge. Harvest may occur on slopes between 50-70% above inner gorge slopes following on-site review by geotechnical expert.
2. Any road construction or reconstruction, within MWMU #34H will be reviewed by a geotechnical expert.
3. Include fully engineered road from Tolt WA. section.

Management Objective:

Prevent acceleration of mass-wasting in MWMU #34H above natural rates.

Technical rationale:

Root strength/road drainage

Voluntary Enhancement/Monitoring:

Existing access roads above the Linger Longer road in MWMU #34H, should be upgraded to provide adequate drainage to avoid directing road runoff to unstable slopes.

BIG QUILCENE PRESCRIPTION #30.

Resource Sensitivity Number: CMR #89 MWMU #38 Segments BJ, BF, BG, BK, BL, and BM, (NHC)
(Tributaries between Spencer Creek and Big Quilcene).

Situation Sentence for the Area (from causal mechanism report):

Fine sediment from MWMU #35H, accelerated by removal of vegetation, roading, and drainage diversion on unstable slopes, will be routed to the mouths of these tributaries and degrade shellfish habitat and production.

Triggering Mechanism (from causal mechanism report):

Loss of root strength on unstable slopes, additional water from diverted road drainage.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

In the landslide inventory using 1939 photography, there is the highest density of landslides of any mass wasting map units within the watershed analysis area. Current inventory shows one active debris slide with direct delivery to the shoreline. Convergent areas immediately below the road at 400 foot contour interval show indications of instability (leaning trees and tree fall). A series of old rotational slumps were observed near the end of the road that follows the 400 foot contour interval.

Prescriptions:

Vegetation Removal and Road Construction, in addition to existing Shoreline Management Act requirements:

1. On >70% slopes and/or concave slopes <70% , no harvest on slopes between mean sea level and 400 feet elevation.
2. Between 400 feet and 500 feet elevation, no harvest in concave landforms (areas converging into tributaries) on 70% slopes.
3. If A or B don't apply, areas with noticeable slope instability features (slumps, etc.) a geotechnical consultant is needed to determine harvest level and road construction.

Management Objective:

Prevent acceleration of mass-wasting in Geomorphic Units 35H above natural rates.

Technical rationale:

Root strength (Sidle and Swanston)

Increasing water drainage to naturally unstable slopes cans accelerate mass movement.

Headland erosion (Tubbs)

Voluntary Enhancement/Monitoring:

Inspection of harvest site after harvest and immediately after major storm events for indications of mass movement.

BIG QUILCENE PRESCRIPTION #31.

Resource Sensitivity Number: CMR #90 Segment BF NHC (South Indian George Creek).

Situation Sentence for the Area (from causal mechanism report):

Loss of riparian vegetation from harvest and residential development in Riparian Units 2 and 3 of this segment have resulted in below-target LWD recruitment potential, affecting fish spawning and rearing habitat.

Triggering Mechanism (from causal mechanism report):

Removal of riparian vegetation by residential development and harvest.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Bank hardening by residential development in Riparian Segment 2

Tidelands and salinity preclude conifer production in Segment 2

Mixed mature dense riparian zone in Segment 3 indicates high likelihood of reduction in LWD potential.

Residential development in Segments 3 has reduced LWD potential in riparian zone.

Prescriptions:

Riparian Unit 3:

1. No harvest of conifer within 66 feet of the stream.
2. Harvest of hardwoods within 66' of the stream allowed for conifer release only.

Voluntary Prescriptions:

Riparian Unit 2:

1. Encourage landowners to retain existing LWD in the channel and retain and plant additional conifer within 66 feet of the stream.
2. Retain driftwood and existing LWD on adjacent streambanks and tidelands.

Management Objective:

Riparian Segment 2: Maintain or improve LWD in the riparian zone and channel.

Riparian Segment 3: Improve stocking of conifer in riparian zone.

Technical rationale:

Murphy and Koski 1989: 95% of LWD is from 66' of the stream.

Removal reduction of deciduous canopy benefits shade intolerant conifer.

Voluntary Enhancement/Monitoring:

Opportunities for instream LWD enhancement may exist within Riparian Segment 2.

BIG QUILCENE PRESCRIPTION #32.

Resource Sensitivity Number: CMR #91 Segment BH-2 SHC (Spencer Creek)

Situation Sentence for the Area (from causal mechanism report):

Direct delivery of fine sediment from road crossing (S1/2, NW1/4, Sec. 13, T26N, R2W) at old log stringer bridge to segment BH-2, is filling pools and affecting possible coho spawning and rearing habitat (up to the falls), and possible resident cutthroat spawning and rearing habitat (above the falls).

Triggering Mechanism (from causal mechanism report):

Road Crossing on stringer bridge.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Road grade on each side of the bridge approach is contributing sediment to the stream channel from road tread and cutslope erosion.

Prescriptions:

1. Revegetate road surface.
2. Construct waterbars every 50 feet for a distance of 200 feet on each side of the stream crossing.

Management Objective:

Prevent fine sediment delivery from road approaches to stream channel.

Technical rationale:

Stream crossing has direct delivery of fine sediment to stream channel. Vegetation provides for as much as 75-90% decrease in rate of delivery from hillslopes. (Megahan, 1981).

Voluntary Enhancement/Monitoring:

Monitor performance of waterbars during rainfall events.

BIG QUILCENE PRESCRIPTION #33.

Resource Sensitivity Number: CMR's #67 and #77 Big Quilcene Mainstem Segments 1,2,3,4,5,6,

Situation Sentence for the Area (from causal mechanism report):

Loss of riparian vegetation from past harvest and residential development in Segments 1 through 6, has resulted in reduced LWD recruitment, and below-target shade, affecting spawning and rearing habitat.

Triggering Mechanism (from causal mechanism report):

Removal of riparian vegetation by harvest, agricultural and residential development (non-forest conversion)

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Riparian harvest, fires, agricultural practices, residential development have reduced LWD recruitment below target in segments 1 through 6 on the Big Quilcene. Shade within channel segments; Big Quilcene segments 1,2, 3 and 4; Penny Creek A1, A3, A4, A5, A6.

Prescriptions:

1. No removal of conifer tree species within 66 feet of the ordinary high water mark of the stream.
2. When shade is above target, harvest of hardwoods allowed for conifer release only within 66 feet of the stream.

Management Objective:

Encourage presence and growth of large conifer trees in riparian zone.

Technical rationale:

Murphy and Koski 1989.

Removal reduction of deciduous canopy benefits shade intolerant conifer.

Voluntary Enhancement/Monitoring:

1. Encourage landowners to retain existing LWD in the channel and retain and plant additional conifer within 66 feet of the stream.
2. Retain driftwood and existing LWD on adjacent streambanks and tidelands.
3. Hardwood removal within 66 feet of the stream will be monitored for release success (success \leq 15% mortality to existing conifer).

BIG QUILCENE PRESCRIPTION #34.

Resource Sensitivity Number: CMR's #13, #71, #82

Situation Sentence for the Area (from causal mechanism report):

Nutrients from residential development (septic drain fields) constructed within the flood plain is degrading water quality.

Triggering Mechanism (from causal mechanism report):

Non-functioning septic drainfields

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Fecal Coliform colonies have been measured in the Big Quilcene fan delta which exceed state water quality standards during winter when water table is or near the surface.

Algae production in the Big Quilcene and Penny Creek just above the Hatchery intakes between April and October.

Management Objective:

Reduce or eliminate human waste and nutrient (N and P) contributions from human development and agricultural practices to waters of the state.

Voluntary Prescriptions:

1. Property Owners, Jefferson County Health and the Department of Ecology should conduct a sanitary survey of the existing septic systems adjacent to the stream.
2. Prevent location of future septic systems in floodplain.
3. Encourage proper use or elimination of fertilizers and other chemicals adjacent to stream channels.
4. Discourage land development within 100-year flood plain which would contribute non-point pollution to waters of the state.

Technical rationale:

Nitrogen and phosphorus can cause eutrophication (Vollenweider, 1979).

Direct discharge of untreated domestic waste to waters of the State is not permitted under RCW 90.48 Water Pollution Control Act.

Fecal Coliform is an indicator species for other human and animal waste products that constitute a health risk for humans.

Voluntary Enhancement/Monitoring:

Encourage landowners to clean and inspect septic systems every 3 years. Monitor algae production at the hatchery. Monitor fecal coliform colonies in the near-shore marine waters at the mouth of the Big Quilcene River.

BIG QUILCENE PRESCRIPTION #35.

Resource Sensitivity Number: CMR's #10 #12 and #73 Penny Creek and Big Quilcene Mainstem

Situation Sentence for the Area (from causal mechanism report):

#10

The water diversion in lower 250' of Segment A-1 is reducing water and sediment flow and eliminating resident and anadromous fish use (all stages). This is also a barrier to anadromous and resident fish migration.

#12

Upstream unmetered withdrawals above hatchery intake in Segment A-1 are reducing water volume available for hatchery operations.

#73

Hatchery diversion of water results in reduced flows in 500 feet of Segment 3, . This affects transport capacity, causing loss of rearing and spawning areas.

Triggering Mechanism (from causal mechanism report):

Water withdrawal.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Stream segment 3 has been observed to go subsurface during low-flow periods.

Total volume between intake and return in segment 3 is reduced.

Voluntary Prescriptions:

All water withdrawals should be metered and monitored to limit water use specified by water rights.
Monitor nature of use for compliance with permitted use.

Management Objective:

Maintain instream flows in Penny Creek and the Big Quilcene River.

Technical rationale:

Reduced instream flows adversely affect all life histories of fish species.

Voluntary Enhancement/Monitoring:

1. Modify hatchery production to reflect available water supply.
2. Implement water conservation program.

BIG QUILCENE PRESCRIPTION #36.

Resource Sensitivity Number: CMR #11 Penny Creek (Segment A-1)

Situation Sentence for the Area (from causal mechanism report):

Coarse sediment transported from upstream and stored by hatchery intake structure is causing local aggradation in settling basin above intake and blocking diversion intakes.

Triggering Mechanism (from causal mechanism report):

Lowered channel gradient from construction of hatchery intake.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Hatchery has to clean out coarse sediment (>2 in) (50 yd³) from Penny Creek settling pond just above hatchery intake approximately every two years.

Voluntary Prescriptions:

1. Redesign intake structure to pass coarse sediment.
2. Avoid delivery of coarse sediment to stream channel upstream of hatchery diversion. Area of the watershed of highest sensitivity for this process is MWMU #78 and potential development in Segment A-1 and A-2.

Management Objective:

Avoid increase in coarse sediment transport to hatchery diversion.

Technical rationale:

Excess sediment accumulation if not removed periodically, will block intake and interrupt hatchery water supply.

Voluntary Enhancement/Monitoring:

Monitor volume of material removed from settling ponds.

BIG QUILCENE PRESCRIPTION #37.

Resource Sensitivity Number: CMR #7 Penny Creek (Segment A-4)

Situation Sentence for the Area (from causal mechanism report):

Fine sediment from Road 3057 (at stream crossing) is entering Segment A-4 and is filling pools and degrading resident fish spawning and incubation locally, and increasing turbidity to hatchery water supply.

Triggering Mechanism (from causal mechanism report):

Road outsloping of 3057.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Wide, outsloped gravel surfaced road with ditchlines delivering directly to the stream.

Voluntary Prescriptions:

1. Redirect drainage to prevent water flow across running surface.
2. Add lift of screened quarry rock to achieve a crowned running surface.
3. Reconstruct road to achieve inslope road tread.

BIG QUILCENE PRESCRIPTION #38.

Resource Sensitivity Number: CMR #7a Penny Creek (Segment A-4)

Situation Sentence for the Area (from causal mechanism report):

Culvert under Road 3057 (at stream crossing) is blocking upstream fish migration.

Triggering Mechanism (from causal mechanism report):

Culvert installation.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Excessive gradient, jump pool is wrong configuration, vertical height on downstream end is too high (2'), boulders placed immediately under spill.

Voluntary Prescriptions:

Replace culvert with 100-year flow capacity at grade or pull the culvert and construct a bridge.

Management Objective:

Reestablish fish passage through culvert.

Technical rationale:

Hydraulic control at culvert exceeds physiologic capacity of fish to move upstream through the culvert.

Voluntary Enhancement/Monitoring:

Conduct fish population survey that compares summer use above and below the culvert after repair.

BIG QUILCENE PRESCRIPTION #39.

Resource Sensitivity Number: CMR #10 (Segment A-1)

Situation Sentence for the Area (from causal mechanism report):

The water diversion in lower 250' of Segment A-1 is reducing water and sediment flow and eliminating resident and anadromous fish use (all life stages). This is also a barrier to anadromous and resident fish migration. The combination of electric fish weir, culvert, fish ladder, and diversion prevent adult fish passage upstream and downstream.

Triggering Mechanism (from causal mechanism report):

Hatchery operations.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Cutthroat trout have been observed caught in the diversion intake screen.

Voluntary Prescriptions:

Engineer a passage route for fish through the hatchery reach.

Management Objective:

Examine the possibility of establishing fish passage through the hatchery diversion reach.

Technical rationale:

There is approximately 2.5 miles of potential coho and cutthroat spawning and rearing habitat above the hatchery which could be used if it was accessible.

Voluntary Enhancement/Monitoring:

BIG QUILCENE PRESCRIPTION #40.

Resource Sensitivity Number: CMR's #1-6,8 Penny Creek (Segment A-1 through A-10)

Situation Sentence for the Area (from causal mechanism report):

The fire of 1925 has contributed to mass wasting and surface erosion in Geomorphic Unit #78. Fine sediment has been contributed to these Segments from resorting of deposited mass wasting material from debris tracks within this mapping unit. This will degrade fish rearing, holding and spawning habitat.

Triggering Mechanism (from causal mechanism report):

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Voluntary Prescriptions:

1. No vegetation removals on 70% or greater slopes on inner-gorge slopes in MWMU #78. On hillslopes between 50-70% located upslope of >70% inner gorge slopes and harvest may occur following an on-site review by a slope stability expert. Refer to attached MWMU #78 definition. Harvest on 50-70% slopes will be conducted in such a way that delivery of coarse and fine sediment to the stream channel is prevented.
2. Any new road construction proposed in #78 will be designed and field reviewed by a professional engineer.

Management Objective:

Avoid acceleration of mass wasting rate in MWMU #78.

Technical rationale:

Loss of root strength from vegetation removal reduces effective soil cohesion and increases slope instability.

Road construction sidecast material is unstable on slopes >55%.

Voluntary Enhancement/Monitoring:

BIG QUILCENE PRESCRIPTION #41.

Resource Sensitivity Number: CMR #75 Segment 3, Big Quilcene Mainstem

Situation Sentence for the Area (from causal mechanism report):

Operation of electric weir from May-December is diverting migrating chum and coho, in the lower end of Segment 3, at hatchery. This is also resulting in a loss of natural production of anadromous salmonids in the basin.

Triggering Mechanism (from causal mechanism report):

Electric weir.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

May through December, weir is in operation. Little anadromous fish use observed above the weir between May through December.

Weir prevents fish access into approximately 4 miles of diverse habitat, except during power outages or equipment failure and high flows.

Voluntary Prescriptions:

1. Operate the weir to allow escapement of representative portions of anadromous fish runs into upper basin up to the falls.
2. Determine necessity of water treatment against pathogens.
3. Install water treatment device to treat Big Quilcene water supply for fish pathogens.

Management Objective:

Facilitate coho and chum production above the weir.

Technical rationale:

Modification of weir operation would allow for a substantial increase in natural production of anadromous species, primarily chum and coho.

Voluntary Enhancement/Monitoring:

Conduct spawning surveys above weir up to River segments 3,4,5,6,7,8.

BIG QUILCENE PRESCRIPTION #42.

Resource Sensitivity Number: CMR # 74

Situation Sentence for the Area (from causal mechanism report):

The hatchery diversion and levee complex is causing local deposition of coarse sediment and changing channel surface patterns in Segment 3. This results in loss of summer side channels, rearing habitat and high flow refuge.

Triggering Mechanism (from causal mechanism report):

Diversion and levee complex.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Stream channels is responding to hydraulic control of the intake structure and levee/dike by aggrading headward and filling side channels.

Voluntary Prescriptions:

1. Remove concrete sill and levee controls. Move hatchery intake site upstream to a more stable reach.
2. Establish stable roughness elements (LWD) in the channel to provide hydraulic diversity and high flow refuge.

Management Objective:

Preserve and restore summer side channels, rearing habitat and high flow refuge.

Technical rationale:

This segment is the first deposition reach of the mainstem Big Quilcene. Any vertical hydraulic control is going cause channel adjustments. This will be a continual maintenance obligation for the hatchery.

Voluntary Enhancement/Monitoring:

BIG QUILCENE PRESCRIPTION #43.

Resource Sensitivity Number: CMR #76 Segment 3 (Big Quilcene Mainstem).

Situation Sentence for the Area (from causal mechanism report):

1. Outplanting of resident trout juveniles and adults in the upper watershed has resulted in displacement or "loss" of resident cutthroat (and resident rainbows) in all but upper Townsend Creek.
2. Outplanting of anadromous juveniles (both fry and pre-smolt) in past and on-going artificial production programs in the Big Quilcene system has had several effects on naturally (endemic) reproducing stocks of summer and fall chum, coho, winter steelhead, and sea-run cutthroat.

Triggering Mechanism (from causal mechanism report):

Introduction of non-native stock.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Voluntary Prescriptions:

Management Objective:

Technical rationale:

Voluntary Enhancement/Monitoring:

BIG QUILCENE PRESCRIPTION #44.

Resource Sensitivity Number: CMR #72 (Segment 3)

Situation Sentence for the Area (from causal mechanism report):

Peak flows in Segment 3 are transporting coarse sediments, clogging hatchery intakes, restricting water supply for hatchery operations and contributing to erosion of levees built to direct river flows to hatchery intake.

Triggering Mechanism (from causal mechanism report):

Peak flows due to hydrologic immaturity of watershed.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Flooding in this reach occurs an average of 3 times per year. During peak flows coarse sediment is mobilized clogs hatchery intakes. Coarse gravels form bars in front of hatchery intake which reduces the amount of water available for diversion during low flow.

Voluntary Prescriptions:

Hydrologic maturity (vegetation age) within the Rain-on-snow zone (Elev.) shall be maintained at __% or greater.

Management Objective:

Maintain a distribution of vegetation age classes and densities that will maintain water storage at or below current level.

Technical rationale:

By maintaining or reducing the area of the watershed in young forest, increased delivery of water to stream channels during ROS events is ameliorated.

Voluntary Enhancement/Monitoring:

Install flow or crest gauge. Annual air photo monitoring of percentage of ROS zone in young forest (<10 yrs.).

BIG QUILCENE PRESCRIPTION #45.

Resource Sensitivity Number: CMR #84 Segment 1, (Big Quilcene Main Stem).

Situation Sentence for the Area (from causal mechanism report):

Channel confinement from levee construction has eliminated side and tidal channel habitat for salmonids, and eliminated spawning, rearing, and holding habitat in Segment 1.

Triggering Mechanism (from causal mechanism report):

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Mouth of the Big Quilcene once consisted of a anastomosing system of tidal channels. Signatures of this system are still evident in air photos. Construction of levees has channeled and simplified the marine and stream-channel habitat. Remnant tidal channels are still used by late fall chum.

Voluntary Prescriptions:

Reconnect remnant tidal channels with the Big Quilcene River either by actively breaching the levees or by curtailing levee maintenance.

Management Objective:

Increase tidal and side channel habitat for salmonids, specifically for summer chum and pink adults and fry.

Technical rationale:

Levee construction has resulted in a significant reduction in the area and complexity of fish habitat by preventing physical access. What fish habitat remains is unstable. Eliminating the levees will re-establish the river flood plain which will increase habitat area, diversity, and cover for pink and chum fry and increase spawning area for critically depressed chum and pink salmon stocks. (REF???)

Voluntary Enhancement/Monitoring:

1. Seasonal surveys for adult spawning and juvenile fish presence.
2. Habitat assessment and classification.

BIG QUILCENE PRESCRIPTION #46.

Resource Sensitivity Number: CMR's 69, #70, #78

Situation Sentence for the Area (from causal mechanism report):

Segment 2: Coarse and fine sediment from past and existing bank mass wasting, as a result of channel adjustment and loss of root strength, is fining and reducing pools in this segment. This is affecting spawning, rearing, and holding habitat.

Segment 3: Coarse and fine sediment from past and existing bank mass wasting, as a result of channel adjustment, is fining and reducing pools in Segment 3, , and the bypass reach below hatchery intakes. This is affecting spawning, rearing, and holding habitat.

Fine sediment from bank mass wasting and mobilization of in-channel storage in Segment 3 and above, due to "moderate" and peak-flow events, is creating lateral bars and "fining" the bed locally in Segment 3. This is affecting spawning, rearing, and holding capacity for fish.

Triggering Mechanism (from causal mechanism report):

1. Channel Adjustment
2. Flows undercutting bank.
3. Loss of root strength.

Rule Call for Management Prescriptions (from causal mechanism report: Natural Channel Processes.

Field Observations:

Steep bluff on south side of river is being undercut by the stream channel which is contributing fine sediment through progressive bank failure. Points observed downstream of highway 101 and banks immediately upstream of hatchery intakes.

Prescriptions:

Within Segment 2, on the South side of the Big Quilcene river and to point 1500 feet downstream of tributary B, no vegetation removal or new road construction below 200 foot elevation contour.

Reference CMR #95 and #67

Management Objective:

Maintain and encourage vegetative root strength along channel edge in segments 2 and 3.

Technical rationale:

Bank cutting on the outside turn has potential to generate a failure plane which could extend to the 200 foot contour interval. Ward et al. (Dan Miller pers. comm.)

Voluntary Enhancement/Monitoring:

1. Monitor rate of bank cutting.
2. Encourage growth of woody perennials along streambanks.

BIG QUILCENE PRESCRIPTION #47.

Resource Sensitivity Number: CMR's #79,80,81,83 mainstem Big Quilcene

Situation Sentence for the Area (from causal mechanism report):

See situations for CMR's #79,80,81,83

Triggering Mechanism (from causal mechanism report):

Levee construction and maintenance primary.

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Increased stream channel aggradation over natural rates (Brian Collins Tech Report). Jefferson County Comprehensive Flood Management Plan for the Big Quilcene and Dosewallips Rivers. 1993. Breach of levees during flooding in 1990's lead to levee reconstruction and channel manipulation by earth moving equipment. Highly mobile bed material has been observed in these reaches.

Prescriptions:

1. Breach levees in appropriate places to establish side channels and reconnect the Big Quilcene mainstem to the 100 year floodplain.
2. Included in the analysis for returning the channel to its flood plain, the Linger Longer bridge and the BPA Power tower design and location should be examined.

Management Objective:

Re-establish hydrologic function of the 100 year floodplain while protecting public works and fishery resources.

Technical rationale:

Levee construction has resulted in a significant reduction in the area and complexity of fish habitat by preventing physical access. What fish habitat remains is unstable. Eliminating the levees will re-establish the river flood plain which will increase habitat area, diversity, and cover for pink and chum fry and increase spawning area for critically depressed chum and pink salmon stocks. (REF???). and disperses channel aggradation over a larger area which lowers the elevation of flood waters.

Channel confinement reference.

Voluntary Enhancement/Monitoring:

1. Seasonal surveys for adult spawning and juvenile fish presence.
2. Habitat assessment and classification.
3. Hydrologic stage and flow monitoring.

BIG QUILCENE PRESCRIPTION #48.

Resource Sensitivity Number: CMR #59 (Segment 16,17,18,19) Big Quilcene Mainstem

Situation Sentence for the Area (from causal mechanism report):

Elevated peak flows are causing channel changes (lateral bar formation and fine sediment transport) and creating a loss of pool-forming structures.

Triggering Mechanism (from causal mechanism report):

Peak flow due to high hydrologic immaturity (percent of young forest).

Rule Call for Management Prescriptions (from causal mechanism report: Prevent or Avoid.

Field Observations:

Voluntary Prescriptions:

Hydrologic maturity (vegetation age) within the Rain-on-snow zone (Elev.) shall be maintained at __% or greater.

Management Objective:

Maintain a distribution of vegetation age classes and densities that will maintain water storage at or below current level.

Technical rationale:

By maintaining or reducing the area of the watershed in young forest, increased delivery of water to stream channels during ROS events is ameliorated.

Voluntary Enhancement/Monitoring:

Install flow or crest gauge. Annual air photo monitoring of percentage of ROS zone in young forest (<10 yrs.).

